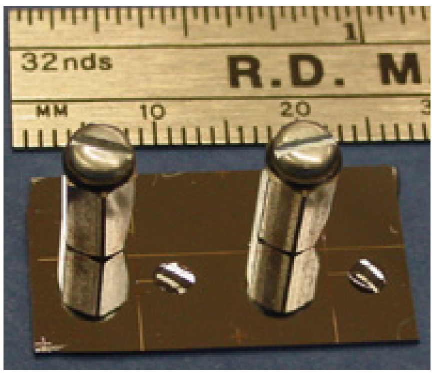
Researchers achieve atomic spectroscopy on a chip

June 1 2007



Atomic spectroscopy on a chip was achieved using this device, which features interconnected waveguides, rubidium vapor cells, and fiber-optical access. Photo courtesy of H. Schmidt

Researchers at the University of California, Santa Cruz, have performed atomic spectroscopy with integrated optics on a chip for the first time, guiding a beam of light through a rubidium vapor cell integrated into a semiconductor chip.

Atomic spectroscopy is a widely used technique with diverse applications. Based on the interactions of light and matter, spectroscopy is often used to identify substances by the wavelengths of light they absorb or emit. Conventional systems have many large components, whereas the compact, fully planar device developed at UCSC enables the study of atoms and molecules on a chip-based platform with integrated optics, said Holger Schmidt, associate professor of electrical engineering.

Schmidt's group and his collaborators at Brigham Young University described the first monolithically integrated, planar rubidium cell on a chip in a paper published in the June issue of Nature Photonics. The first author of the paper is Wenge Yang, a postdoctoral researcher in Schmidt's lab at UCSC's Baskin School of Engineering.

According to Schmidt, potential applications for this technology include frequency stabilization for lasers, gas detection sensors, and quantum information processing.

"To stabilize lasers, people use precision spectroscopy with bulk rubidium vapor cells. We could build a little integrated frequency stabilization chip that would do that more easily than a conventional frequency stabilization circuit," Schmidt said.

That project is already under way in Schmidt's lab. Other applications, such as quantum information processing, are more long-term goals, he said.

The key to the group's achievement is their development of hollow-core optical waveguides based on antiresonant reflecting optical waveguide (ARROW) principles. In previous publications, Schmidt and his collaborators have described other uses of ARROW waveguides integrated into chips using standard silicon fabrication technology (see http://press.ucsc.edu/text.asp?pid=578).

To perform atomic spectroscopy, the researchers incorporated rubidium reservoirs into a chip, connecting the reservoirs to hollow-core waveguides so that the optical beam path is filled with rubidium atoms. The resulting vapor cell is completely self-contained and has an active cell volume about 80 million times smaller than a conventional cell, Schmidt said.

"We used rubidium as a proof of principle, but this technique is applicable to any gaseous medium. So it has potentially far-reaching implications," Schmidt said.

In addition to its use in laser frequency stabilization, rubidium vapor is widely used in quantum optics experiments and has been used to slow the speed of light.

"Fundamental concepts in quantum information processing have been demonstrated in principle using bulk rubidium systems. To be practical you can't have big optical tables in all the places you would want to use it, but now we can make this technology more compact and portable," Schmidt said.

Source: University of California - Santa Cruz

Citation: Researchers achieve atomic spectroscopy on a chip (2007, June 1) retrieved 24 April 2024 from https://phys.org/news/2007-06-atomic-spectroscopy-chip.html